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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 09/682,054 | 07/16/2001 | Chih-Ning Wu | NAUP0374USA | 6941 |

27765 7590 03/14/2003

NAIPO (NORTH AMERICA INTERNATIONAL PATENT OFFICE)
P.O. BOX 506
MERRIFIELD, VA 22116

EXAMINER

UMEZ ERONINI, LYNETTE T

ART UNIT

PAPER NUMBER

1765

DATE MAILED: 03/14/2003

4

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/682,054

Applicant(s)

WU, CHIH-NING

Examiner

Lynette T. Umez-Eronini

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-19 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 8, 14 and 19 is/are allowed.
- 6) ☐ Claim(s) 1-7, 9-13, and 15-18 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) ____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). ____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Drawings

1. The drawings are objected to because they are illegible.

Claim Objections

2. Claims 1 and 11 are objected to because of the following informalities:

In claims 1 and 11, "NH₂OH" should read --NH₄OH--. Appropriate correction is required.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 6 and 17 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

On lines 2-3, "reducing the H₂O₂ concentration of the diluted H₂O₂ solution to below 100:1 (v/v)" is indefinite because it is unclear what two components are referred to in the volumetric ratio.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

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(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1 and 2 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's admitted prior art.

Applicant's admitted prior art discloses a post-etch dual damascene structure **30** that is formed on a silicon substrate **10** (page 2, [0007]) and Cu wiring line **24** which is electrically connected with a N^+ diffusion region **12** of the silicon substrate **10** via a tungsten plug **16** (page 2, [0007]). Although Fig. 1 is illegible, one can make out applicant's Cu wiring lines **22** and **24**, which lie in a trench and the via that overlies each of the trenches. Hence, the aforementioned reads on,

providing a wafer comprising a silicon substrate and at least one post-etch Cu-dual damascene structure, the post-etch Cu-dual damascene structure having a via structure having a via structure exposing a portion of a Cu wiring line electrically connected with an N^+ diffusion region of the silicon substrate and a trench structure formed on the via structure.

Applicant's admitted prior art discloses a method to clean copper structures after via/trench dry etch using a two-step process that is based on a mild oxidation step that consists of dilute H_2O_2 and a surfactant and oxidizing the copper surface and on an etching step that uses dilute HF, NH_4F or NH_2OH and removes oxide, such as CuO_x , and $Cu(OH)_2$ from the copper surface (page 2, [0006]), which reads on,

applying a diluted H_2O_2 solution to the wafer to slightly oxidize the surface of the exposed Cu wiring line; and

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washing away cupric oxide generated in the oxidation step by means of a cupric oxide cleaning solution containing diluted HF, NH_4F , or NH_2OH .

Since applicant's admitted prior art uses the same method of oxidizing copper and washing away the oxidized copper on a post-etch dual damascene structure like that of the claimed invention, then using the damascene structure and method of applicant's admitted prior would inherently result in an extrusion-free wet cleaning process for post-etch Cu-dual damascene structures and prevent Cu reduction reactions on the N^+ diffusion region connected Cu wiring line, as in the claimed invention, as in the present **claim 1**.

Applicant's admitted prior art discloses a reasonable explanation for undesirable extrusion atop Cu wiring **24**, which is electrically connected with a N^+ diffusion (electron-rich) region **12** the silicon substrate **10** via a tungsten plug **18**, after a post-etch dual damascene structure **30** has under been treated with HF solution (same as applicant's cupric oxide cleaning solution). Excessive copper ions deposit on the anode (i.e. N^+ region connected Cu wiring line) due to reduction reaction (see eq. 2) and in the reduction of cupric oxide the oxidation number of copper has changed from +2 to zero, (page 3, [0007]). The aforementioned reads on, wherein the Cu wiring line electrically connected with an N^+ diffusion region of the silicon substrate serves as a cathode in the cupric oxide cleaning solution, as in **claim 2**.

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7. Claims 3-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's admitted prior art as applied to claim 1 above, and further in view of Bayes et al. US 6,054,061).

Applicant's admitted prior art differs in failing to teach preventing Cu reduction reaction on the Cu wiring lines comprises adding a Cu corrosion inhibitor to the diluted H₂O₂ solution, as in claim 4; wherein the Cu corrosion inhibitor comprises benzotriazole (BTA), as in claim 5; and preventing Cu reduction reaction on the Cu wiring lines comprises lowering the temperature of the diluted H₂O₂ solution to below 15°C during the application to the wafer of the diluted H₂O₂ solution.

Bayes teaches, " . . . a process for treating a metal surface in an adhesion promotion step to form a roughened conversion coated surface comprising contact of the conducting layer of the surface with an adhesion promotion composition comprising 0.1 to 20% by weight hydrogen peroxide, one or more inorganic acids, an amine or quaternary ammonium" (column 4, lines 43-50); " . . . " the composition results in the formation of a roughened conversion coated surface believed to be composed of an insoluble complex of copper (column 4, line 67 – column 5, line 2); and "the corrosion inhibitor . . . is typically selected from one or more of a triazole, tetrazole or imidazole. Unsubstituted and substituted triazoles and benzotriazoles are preferred" (column 5, lines 28-31). The aforementioned reads on, adding a Cu corrosion inhibitor to the diluted H₂O₂ solution, as in claim 4. Since Bayes uses the same chemicals in treating a copper surface (column 1, lines 8-11), then using Bayes treating method and composition would inherently prevent Cu reduction reactions on the Cu wiring lines

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comprising adding Cu corrosion inhibitor to the diluted H₂O₂ and read on, the Cu corrosion inhibitor comprises benzotriazole (BTA), as in claim 5.

Bayes also teaches, "contact with the adhesion promotion composition . . . at a temperature a temperature varying between 20°C and 50°C (column 6, lines 28-34), which provides evidence that varying the temperature is a so-called "result effective variable.

It is the examiner's position that it would have been obvious to one having ordinary skill in the art at the time of the claimed invention to modify Applicant's admitted prior art by using Bayes' method of treating copper with a corrosion inhibitor and diluted H₂O₂ and varying the temperature of the composition, as taught by Bayes since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPA 215 (CCPA 1980).

8. Claims 9-13 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's admitted prior art.

As pertaining to claims 9-13, Applicant's admitted prior art discloses a post-etch dual damascene structure **30** that is formed on a silicon substrate **10** (page 2, [0007]) and Cu wiring line **24** which is electrically connected with a N⁺ diffusion region **12** of the silicon substrate **10** via a tungsten plug **16** (page 2, [0007]). Although Fig. 1 is illegible, one can make out applicant's Cu wiring lines **22** and **24**, which lie in a trench and the via that overlies each of the trenches. Applicant's admitted prior art also discloses a method to clean copper structures after via/trench dry etch using a two-step process that is

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based on a mild oxidation step that consists of dilute H_2O_2 and a surfactant and oxidizing the copper surface and on an etching step that uses dilute HF , NH_4F or NH_2OH and removes oxide, such as CuO_x , and $\text{Cu}(\text{OH})_2$ from the copper surface (page 2, [0006]), which reads on,

an oxidation step;

an oxide etch step for washing away cupric oxide generated in the oxidation step by means of a cupric oxide cleaning solution.

Since applicant's admitted prior art uses the same method of oxidizing copper and washing away the oxidized copper on a post-etch dual damascene structure like that of the claimed invention, then using the damascene structure and method of applicant's admitted prior would inherently result in reducing Cu deposition on a cathode-like copper wiring line of a Cu-dual damascene structure, as in the present invention.

9. Claims 16, 17, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's admitted prior art as applied to claim 9 above, and further in view of Bayes ('061).

Applicant's admitted prior art differs in failing to teach preventing Cu reduction reaction on the Cu wiring lines comprises adding a Cu corrosion inhibitor to the diluted H_2O_2 solution, as in claim 15; wherein the Cu corrosion inhibitor comprises benzotriazole (BTA), as in claim 16; and reducing Cu deposition on a cathode-like

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copper wiring line comprises reducing the H_2O_2 concentration of the diluted H_2O_2 solution to below 100:1 (v/v), as in claim 17.

Bayes teaches, “. . . a process for treating a metal surface in an adhesion promotion step to form a roughened conversion coated surface comprising contact of the conducting layer of the surface with an adhesion promotion composition comprising 0.1 to 20% by weight hydrogen peroxide, one or more inorganic acids, an amine or quaternary ammonium” (column 4, lines 43-50); “. . . ” the composition results in the formation of a roughened conversion coated surface believed to be composed of an insoluble complex of copper (column 4, line 67 – column 5, line 2); and “the corrosion inhibitor . . . is typically selected from one or more of a triazole, tetrazole or imidazole. Unsubstituted and substituted triazoles and benzotriazoles are preferred” (column 5, lines 28-31). The aforementioned reads on, adding a Cu corrosion inhibitor to the diluted H_2O_2 solution, as in claim 15. Since Bayes uses the same chemicals in treating a copper surface (column 1, lines 8-11), then using Bayes’ treating method and composition reads on the process of reducing Cu deposition on a cathode-like copper wiring line, which would reduce the H_2O_2 concentration of the diluted H_2O_2 solution to below 100:1 (v/v), as in claim 17.

Bayes also teaches, “contact with the adhesion promotion composition . . . at a temperature a temperature varying between 20°C and 50°C (column 6, lines 28-34), which provides evidence that varying the temperature is a so-called “result effective variable.

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It is the examiner's position that it would have been obvious to one having ordinary skill in the art at the time of the claimed invention to modify Applicant's admitted prior art by using Bayes' method of treating copper with a corrosion inhibitor and diluted H₂O₂ and varying the temperature of the composition, as taught by Bayes since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPA 215 (CCPA 1980).

Allowable Subject Matter

10. Claims 8, 14, and 19 are allowed.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lynette T. Umez-Eronini whose telephone number is 703-306-9074. The examiner is normally unavailable reached on the First Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin Utech can be reached on 703-308-3836. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Itue
March 10, 2003


GEORGE GOUDREAU
PRIMARY EXAMINER